



## **CHAPTER 6**

### AIRSPACE REDESIGN

## 6 Airspace Redesign

The growth of aviation traffic in the past decade has placed increasing demands on the FAA to enhance airspace capacity. When airport congestion exacerbates airspace congestion, controllers respond by initiating restrictions such as en route holding of aircraft and miles-in-trail restrictions to moderate the flow of aircraft into terminal areas. In addition, at many airports, flights must funnel through common arrival or departure fixes, which reduces throughput rates due to the large number and types of aircraft with varying performance characteristics using the same airspace.

The FAA is reviewing the structure of the nation's airspace and redesigning it to improve throughput and provide user flexibility, consistent with evolving air traffic and avionics technologies. This umbrella airspace initiative, referred to as National Airspace Redesign, encompasses several regional redesign efforts. In addition, the recently completed National Choke Points initiative focused on short-term solutions to problems in chronically congested airspace in the Northeast, and the high-altitude redesign project is addressing congestion in en route airspace.

FAA airspace planners are using various approaches to increase airspace capacity and minimize the need for air traffic restrictions, including re-sectorization, consolidating and expanding terminal airspace, and developing area navigation routes. Sectorization is the processes whereby the FAA divides the airspace into appropriately-sized and -shaped volumes that facilitate safe and orderly traffic flows and provides a manageable level of work for the air traffic controllers assigned to each sector. Consolidating terminal airspace reduces the amount of coordination required to handle arriving and departing aircraft, and expanding it frequently allows controllers to begin to reduce aircraft spacing further out from the airport. The development of RNAV arrival and departure procedures allows more efficient use of constrained terminal airspace, because arrival and departure streams can be closer together than those governed by ground-based navigation aids.

### 6.1 The National Choke Points Initiative

In 2002, the FAA completed the 2-year National Choke Points initiative. This initiative focused on short-term actions to improve air traffic flow at seven problem areas located in the highly traveled airspace “triangle” between Chicago, Washington, D.C., and Boston. This area includes many of the country's major population areas and its most congested airports.

The FAA used a combination of techniques to successfully alleviate the choke points. The most common approaches were reorganizing existing sectors, creating new sectors, and adjusting controller staffing accordingly. In all, 19 new sectors were created. In addition, the FAA modified aircraft routes, and separated slower traffic to facilitate smooth flow. The choke point initiative has succeeded in reducing delays in these areas by an average of 23 percent. Examples of steps that were taken to address choke points are described below.

- Cleveland Center airspace has historically been complex and difficult to manage because of the proximity of Detroit, Cleveland, Pittsburgh, and Cincinnati airports, and the significant traffic in the New York to Chicago corridor. To address these issues, several sectors were realigned and three new sectors were opened. For example, in November 2001, a new sector called Geauga Sector “Ultra-High”

was created to relieve the pressure in this area by stratifying existing sectors at FL370 and above (Figure 6-1). Another sector, Dansville, was split horizontally to streamline the east-west flow of traffic between New York and Boston Centers to Chicago, and airports within Cleveland Center airspace. In the Pittsburgh area, the Clarksburg Sector was opened as part of a several sector reconfiguration designed to reduce the complexity of traffic in that area. This change benefited traffic destined to Philadelphia, Washington, Baltimore, and Cleveland.

- In Washington center airspace, arrival flows from the south into Newark and LaGuardia, had previously passed through narrow sectors on crossing flight paths. In December 2001, the FAA reversed or “flip-flopped” routes to LaGuardia and Newark airports, which created parallel flight paths to replace the crossing flight paths (Figure 6-2). During the first few months of use, the flip-flop allowed controllers to reduce miles-in-trail restrictions and reduced delays on both approaches. In addition, the adjustment has reduced the noise impact in some communities under the Newark arrival path.

**Figure 6-1** New Geauga “Ultra High” Sector in Cleveland Center

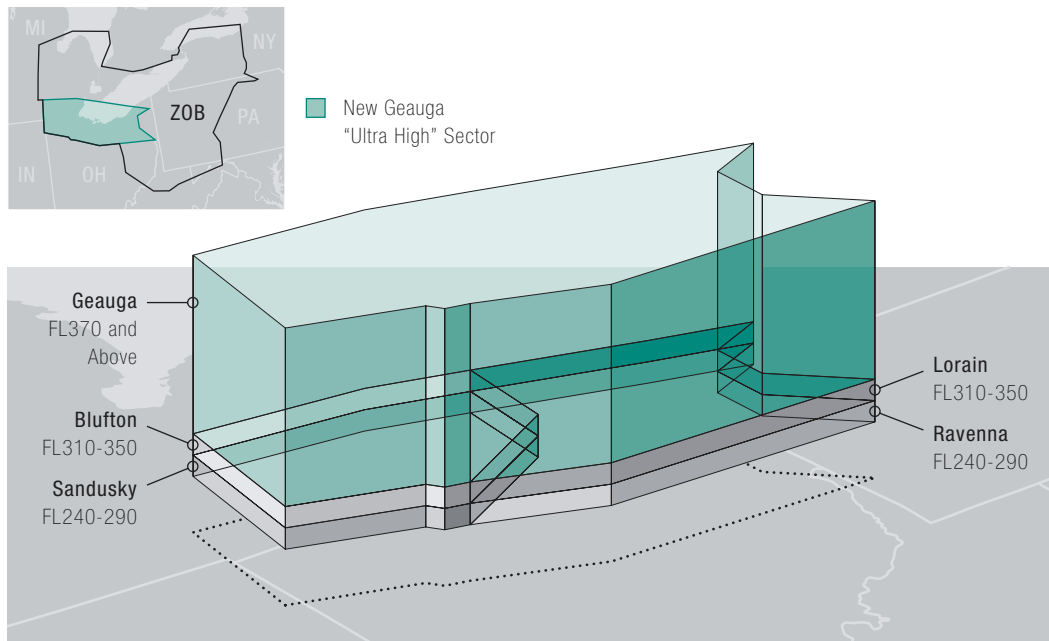
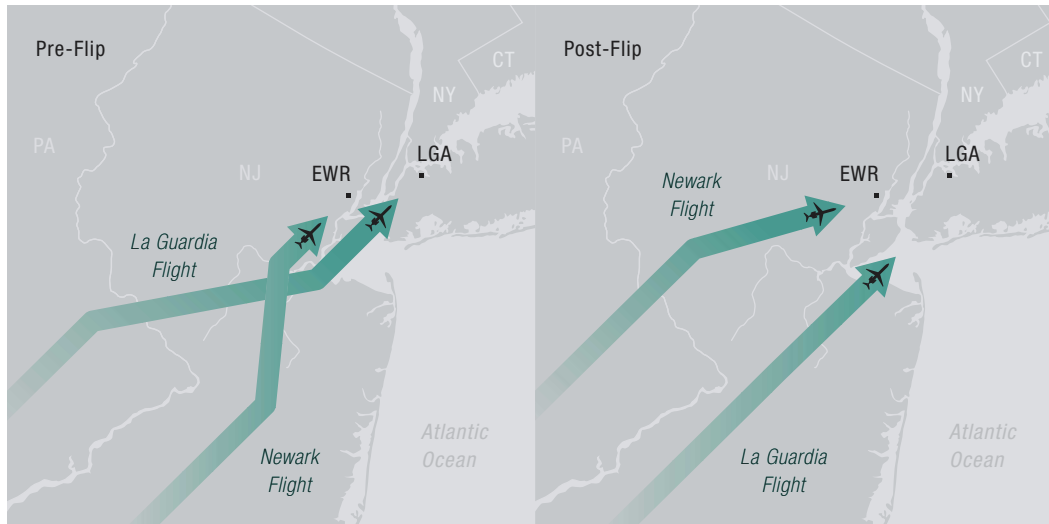


Figure 6-2 "Flip-Flop" of Routes into Newark and LaGuardia Airports



## 6.2 High Altitude Airspace Redesign

High-altitude redesign focuses on efficient flow of en route operations. Currently, aircraft that are flying near or across sector boundaries are frequently delayed as they are handed off from one air traffic control facility to another. The objective of high altitude airspace redesign is to allow users to fly preferred routes and altitudes with fewer restrictions and delays than the present system requires. The airspace above FL350 will be redesigned to allow this flexibility with minimal constraints.

Current procedures to separate traffic require longitudinal separation of five miles in en route airspace. When two aircraft are flying along the same airway, they are kept in trail, one behind the other, which can delay the trailing plane. If the two aircraft are heading for different airports, it should be possible for them to fly on parallel routes, maintaining safe separation but enabling both to operate at optimal speed. Parallel routing will reduce the inefficiencies and workload created by placing aircraft in trail as the primary means of providing structure and controlling volume.

The FAA has created a high-altitude program office to develop high-altitude alternatives. Preliminary high-altitude airspace modifications for the northwest portion of the country are being modeled, with initial implementation planned for 2003. This first phase uses parallel RNAV routes in high-traffic and confined airspace and navigation waypoints for tactical navigation around weather and special use airspace.

The Great Lakes Corridor En Route Redesign project is another FAA project with a high-altitude redesign component. In the Great Lakes region (including Chicago, Minneapolis, Indianapolis, and Chicago centers), many sectors regularly impose miles-in-trail restrictions to mitigate sector saturation or complex workload. This project will focus on reducing sector complexity, procedural and automation enhancements to reduce restrictions, routing through special use airspace when available, and development of RNAV routes.

### **6.3 New York/New Jersey/Philadelphia Metropolitan Redesign Project**

More passengers and planes fly in and out of the New York/New Jersey/Philadelphia metropolitan area than any other area in the U.S. This area services more than 8,000 flights per day, and more than 99 million passengers per year. The metropolitan area airports and their terminal airspace were not designed to handle this volume of traffic and as a result, several of them are among the most delayed airports in the U.S.

The proximity of these airports to one another results in complex pilot/controller and controller/controller coordination and circuitous flight paths. The complex flow patterns make it difficult for controllers to reroute flights from an overloaded arrival fix to a less loaded fix, which consequently results in aircraft being placed into a holding pattern. Holding is used to maximize utilization at an arrival airport by maintaining a line of holding aircraft near the airport. The constant availability of arriving aircraft allows airlines to use arrival slots as soon as they become available. If there are no aircraft near the airport waiting to fill slots as soon as they open, arrival capacity is wasted. Due to the high volume of traffic and the limited holding capacity near the metropolitan area, much of the airborne holding for New York area airports occurs outside of the New York Center.

The FAA is in the early stages of redesigning the airspace in the New York/New Jersey/Philadelphia Metropolitan area. The FAA is in the process of designing alternatives to relieve airspace congestion generated by Newark, Kennedy, LaGuardia, Philadelphia and several regional and general aviation airports. The alternatives address traffic in the airspace currently controlled by the New York TRACON, roughly a 50-mile radius around the TRACON.

One alternative would modify existing traffic patterns principally by the creation of RNAV routes. The number of routes into and out of the New York TRACON is limited today by current radar technology. The increased navigational capabilities offered by advanced navigational systems such as flight management systems and the global positioning system would allow the creation of RNAV routes that can be spaced closer together than existing routes. This would increase throughput, while reducing delays and flight.

Another alternative, referred to as the Four Corner Concept, would establish four arrival areas around the metropolitan area. Once aircraft overfly the corner fix, they could proceed directly to the destination airport, or to another corner, or enter into a large overhead circular pattern to await final sequencing into their ultimate destination airport. Aircraft in the circular pattern would be stacked at different altitudes to accommodate large quantities of aircraft in the metropolitan area. Departing aircraft would be routed between the four arrival areas.

The Ocean Routing Concept is focused on departure procedures for EWR, but affects JFK and LGA flight procedures as well. Under this concept, Newark departures from the south runways (22L/R) would be routed eastbound over the Atlantic, regardless of their destination. Aircraft would turn back toward their destinations after gaining altitude to reduce the impact of aircraft noise on the underlying communities.



In addition, another “clean sheet” approach is being explored. The airspace redesign team is in the process of finalizing the alternatives. Once the alternatives are complete, the environmental analysis will begin, including noise modeling.

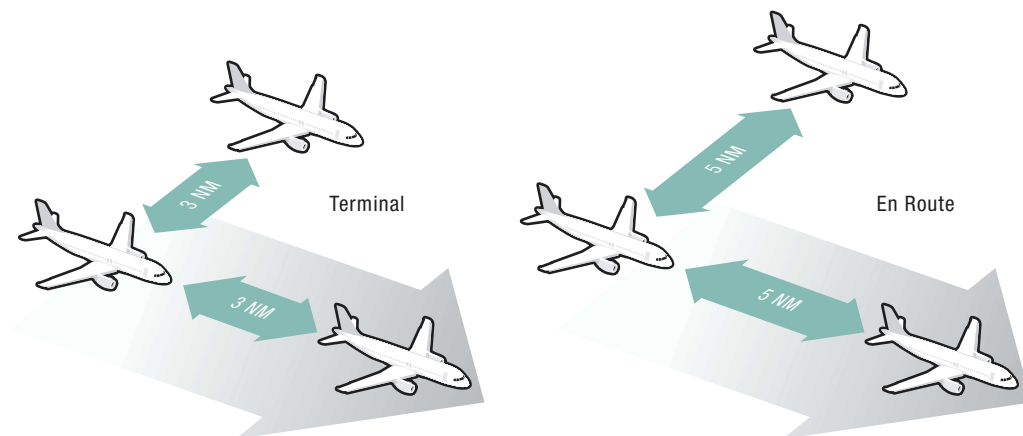
#### 6.4 Phoenix Airspace Redesign

In February 2002, the FAA introduced airspace and procedural changes for flights serving Sky Harbor and other Phoenix-area airports. These changes are an element of Northwest 2000, which seeks to optimize the airspace controlled by the Phoenix TRACON and the nearby high-altitude airspace controlled by the Albuquerque Center. The redesign of Phoenix airspace is based on conventional procedures (using radar vectoring) in the initial phases, with introduction of RNAV procedures over time. On a recent test flight into Phoenix using an RNAV arrival route, the aircraft saved approximately four minutes of flight time.

#### 6.5 Consolidation of Terminal Airspace Control

Typically, a TRACON controls aircraft within 5 and 50 miles of an associated airport. In metropolitan areas with several airports, the terminal airspace of adjacent airports may overlap, creating a complicated airspace structure. In these circumstances, consolidating two or more TRACONs into a single facility can simplify that airspace structure. The consolidation improves communications among controllers handling operations over a wide geographic range and increases their flexibility in merging, maneuvering, and sequencing aircraft to and from the area airports. Additional flexibility can be gained by bringing portions of en route airspace under TRACON control, especially where comprehensive radar coverage allows three-mile spacing rather than the five-mile spacing that is customary in the en route environment (see Figure 6-3). Examples of ongoing FAA efforts to consolidate airspace control are the Potomac Consolidated TRACON (PCT), the Northern California TRACON (NCT), and the New York Integrated Control Complex (NYICC). The PCT and NCT primarily involve consolidating the airspace of several TRACONs, with the addition of relatively small areas of en route airspace. The NYICC would bring large amounts of en route airspace under TRACON control.

**Figure 6-3** En Route vs. Terminal Aircraft Spacing



### 6.5.1 Potomac Consolidated TRACON

The Potomac Consolidated TRACON (PCT) consolidates the radar operations of five airports serving the Washington Metropolitan Area: Andrews Air Force Base (ADW), Baltimore-Washington International Airport (BWI), Dulles International Airport (IAD), Richmond International Airport (RIC) and Washington National Airport (DCA). The building is complete and is scheduled to be commissioned in late 2002.

The PCT will have continuous radar coverage from south of Richmond, Virginia to north of Philadelphia, Pennsylvania, and from as far west as Cumberland, Maryland and east to Cambridge, Maryland. The PCT will gain control of several pieces of airspace that are currently controlled by the en route centers. The expanded and consolidated terminal area airspace will allow the PCT to modify aircraft routes and altitudes to handle inbound and departing aircraft more efficiently. The FAA developed several alternative airspace structures for taking advantage of the consolidated TRACON airspace. Each of the alternatives includes a significant redesign of PCT airspace, but requires varying degrees of coordination and transfer of control with adjacent facilities.

One alternative under consideration for more efficient traffic flow into the Washington/Baltimore area incorporates RNAV routing. Under this alternative, a ring of fixes around the Baltimore/Washington area could be implemented to allow direct routing to and from major cities. Another alternative would establish four arrival and departure areas around the Baltimore/Washington area. A third alternative would maintain most of the existing ingress and egress points into the PCT airspace, while removing the intra-TRACON boundaries and related constraints of the existing airspace structure. This alternative is considered low risk from the viewpoint of implementation because it would not significantly affect the airspace structure of ATC facilities adjacent to PCT airspace. The FAA plans to name its preferred alternative in early 2003.

### 6.5.2 Northern California TRACON

In August 2002 the FAA began transferring air traffic control responsibilities from four existing TRACONs in Northern California (Oakland, Monterey, Sacramento, and Stockton) to the NCT. The transfer of operations will be done in four phases, starting with Sacramento, and ending with Oakland in 2003. When fully commissioned, the NCT will monitor flights in and out of more than 20 airports. The FAA is evaluating airspace alternatives that will take advantage of the operational advantages of the co-located facilities.

### 6.5.3 New York Integrated Control Complex

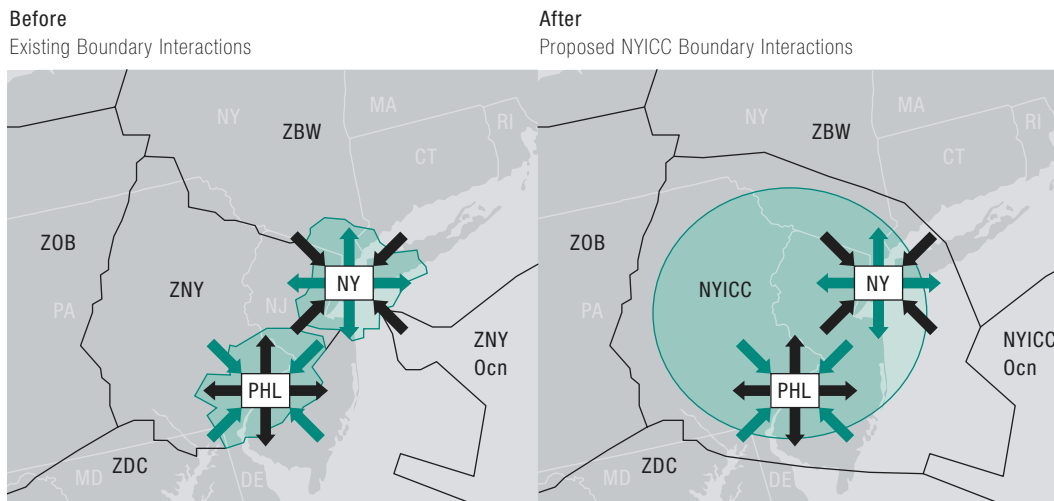
The New York Integrated Control Complex (NYICC) concept emerged from the National Airspace Redesign Team's efforts to optimize airspace and procedures in the New York City-New Jersey-Philadelphia area. The NYICC would potentially integrate terminal airspace from the New York TRACON with portions of the airspace currently controlled by adjacent TRACONs and centers abutting the New York TRACON (Figure 6-4).

Expanding the New York TRACON airspace would reduce the fragmentation of arrival and departure corridors across multiple centers, which currently limits the flexibility to address the dynamic nature of the northeast corridor traffic flows. Bringing portions of en route airspace under terminal control will provide additional airspace to support a more even balance of arrivals among arrival fixes and holding patterns within the TRACON.

Capacity benefits will include reduced delays, reduced restrictions, and enhanced operations during severe weather events.

In 2002, the FAA conducted a human factors analysis of arrival and departure flows involving controllers from the New York TRACON and New York center. Three scenarios were modeled: the current conditions (separate facilities, standard procedures); collocation of TRACON and center controllers so they could observe each other's displays and coordinate face-to-face; and use of less restrictive terminal separation procedures by the en route sector handing-off or receiving traffic to/from the New York TRACON. Preliminary results were supportive of the proposed concepts.

**Figure 6-4** NYICC Concept of Operations



## 6.6 En Route RNAV

One of the limiting factors of the present-day NAS is that aircraft must generally follow airways that are based on a system of ground-based navigational aids. Following those airways involves flying from one navigational fix to another, connecting a series of doglegs, which increases the distance flown and the time required to do so. This is changing with the development of advanced RNAV routes. RNAV routes allow an aircraft to fly a more direct route. In 2001, airlines flying RNAV routes reported a savings of approximately \$31.2 million as a result of time and fuel savings (Figure 6-5). Several recent RNAV route development initiatives are described below.

- In the Southern Region, the FAA has developed 62 multi-center RNAV Routes. Delta is the principal user of 44 routes (flying between Atlanta, Georgia and various Florida cities). Eight of the routes were developed specifically for business jets flying from satellite airports. Delta projects an annual savings of approximately \$3 million from utilizing these routes. US Airways is the principal user of 18 multi-center routes between Charlotte, North Carolina and South Carolina, Georgia and Florida and they estimate annual savings of approximately \$2 million as the result of these routes.



- Atlantic Southeast Airlines operates 47 RNAV routes in the Southern Region, which are projected to generate approximately \$2 million in savings for the airline.
- Since September 2001, Texas to South Florida “Q” routes provides RNAV routing for the Gulf of Mexico (Figure 6-6). These routes are only available to operators equipped for RNAV systems approved for IFR navigation. The routes generate an estimated \$22 million in user savings per year as a result of more direct flights. Continental Airlines reported saving 5 minutes per flight on the new routes. The development of these routes also allowed military warning areas in the Gulf to be redesigned to allow increased training on the next generation of fighter aircraft. Several RNAV routes through the Gulf of Mexico connecting North America to Mexico and South America have also been proposed.
- As of September 2002, the Western-Pacific and Northwest Mountain Regions have developed 21 RNAV routes between key cities. The cities include Seattle, Portland, and Vancouver in the Pacific Northwest, and Los Angeles, San Francisco, San Jose, Oakland, Ontario, Palm Springs, John Wayne-Orange County, Las Vegas, and Phoenix in the Western-Pacific Region. The RNAV routes were developed in conjunction with Alaska Airlines as the lead carrier. The objective of these routes is to provide a seamless RNAV departure, en route, and arrival between the selected airports for all appropriately equipped RNAV aircraft. Alaska airlines project its annual savings as a result of these direct routes to exceed \$800,000.

**Figure 6-5** En Route RNAV Projects

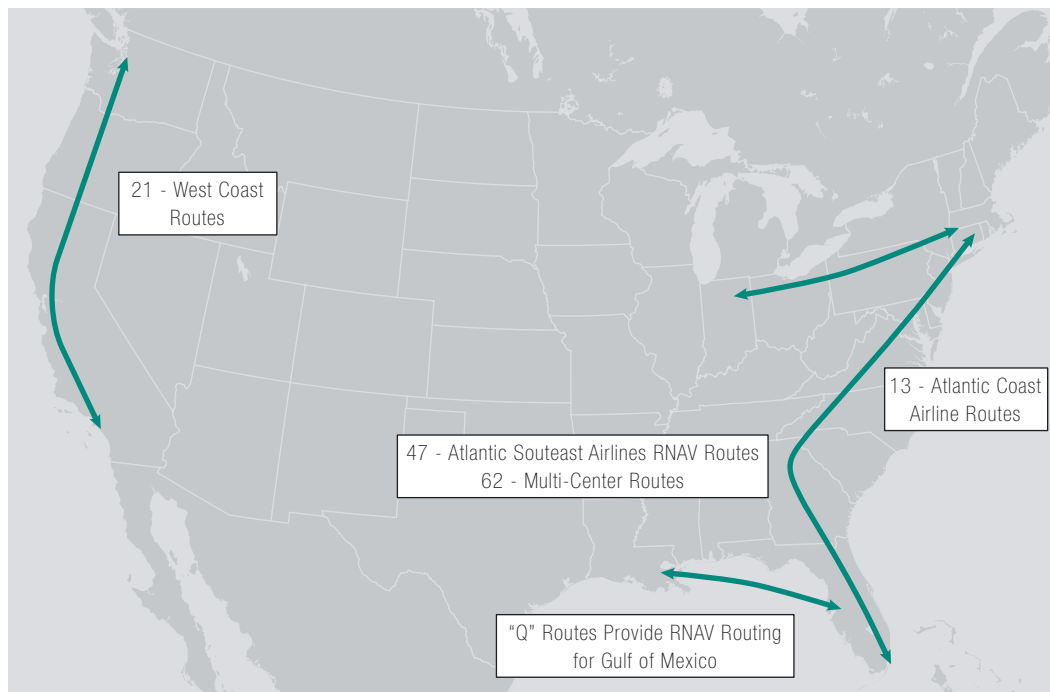
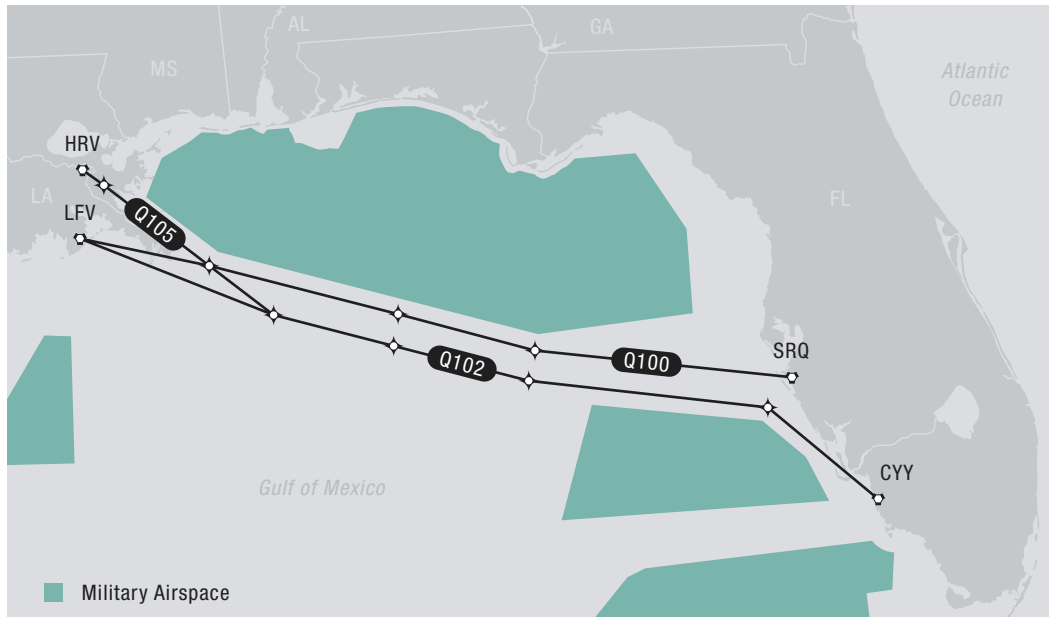


Figure 6-6 RNAV Routes in the Gulf of Mexico



## 6.7 RNAV Arrivals and Departures

RNAV allows for the creation of arrival and departure routes that are independent of existing fixes and navigation aids, and provides multiple entries to existing Standard Terminal Arrival Routes (STARs) and multiple exits from Departure Procedures (DPs). Airports with multiple runways or with shared or congested departure fixes benefit the most from segregating departures and providing additional routings. In addition, a study by MITRE/CAASD estimates that use of RNAV procedures for arriving aircraft reduces the number of pilot/controller voice transmissions required from sixteen for an aircraft guided by ATC heading vectors, to four for an RNAV procedure. The reduction in controller workload improves both safety and system efficiency.

The FAA has developed a three-phase process for the conceptualization, development, testing, commissioning, charting and use of RNAV Terminal Routes. This process provides controllers with the ability to develop new procedures and visualize them with existing traffic flows.

Approximately 40 public use RNAV Departure Procedures (DPs) and Standard Terminal Arrivals (STARs) have been implemented within the NAS. Many of these procedures are “specials” commissioned by particular airlines and subsequently converted to public use. The following is the status of several terminal RNAV projects.

- In October 2001, the Las Vegas TRACON and the Los Angeles Center implemented the 4-corner post (4CP) project, becoming the first major airport to use RNAV arrival and departure procedures for all runways. Los Angeles center has begun adjusting and testing a variety of new RNAV routes to ensure smoother transitions into and out of the terminal area.
- In the Detroit Metropolitan Airport, Northwest Airlines has completed validation flights for a terminal RNAV STAR.

- In Philadelphia, US Airways has been flying an RNAV STAR and DP. These procedures are moving to public charting.
- At the New York Kennedy Airport, American and Delta Airlines have been flying "SKUBY1" (an RNAV STAR).
- At Newark Liberty Airport, Continental Airlines flies two DPs ("SELBY1" and "FILSA").
- At Washington Dulles, Atlantic Coast Airline completed flight simulator trials on a DP, which was subsequently publicly charted in 2001.